copies of the priority documents have not been received. This US patent application is based on the International Application No. PCT/GB98/03011. The USPTO should be provided with the priority documents by WIPO. The Examiner is kindly asked to check on that. In case WIPO did not provide the USPTO with the priority documents, the Examiner is kindly asked to please notify the undersigned.

Remarks

This response is being submitted within one month after the shortened statutory period set for responding to the Office Action that was mailed on September 30, 2002. Therefore we are enclosing herewith a petition and the fee for an extension of time.

Hereinafter the claims that are pending prior to the entry of the amendments in this response are called currently pending claims. This response amends currently pending claims 1, 4-12, 13-18, 20, 21, 25, 29, 33, 34, 35, 39, 40, 41, 44 and 47-50. Upon amendment the above-identified US patent application will have 5 independent claims [amended claims 1, 13, 18, 33 and 44] and a total of 57 claims [currently pending claims 3, 19, 22-24, 26-28, 30-32, 36-38, 42, 43, 46, 51-59 and amended claims 1, 4-12, 13-18, 19, 20-21, 25, 29, 33, 34, 35, 39-41, 44, 47-50]. Applicants have previously paid for 59 total claims and 5 independent claims. Therefore, no excess claims fee has to be paid with this response. The less useful term "short chain" in "short chain polymer" has been canceled in claims 2, 4-6, 14-17, 45, 47-49 since claim 12 defines the oligomer and polymer having repeat units within the range of 4 to 1000.

Claims objection

On pages 2 and 3 of the Office Action the Examiner objects claims 6, 14-17, 18, 20, 21, 22, 24, 25, 29, 33, 34, 39-41 and 49 of informalities. Claims 6, 14-17, 18, 20, 21, 24, 25, 29, 33, 34, 39-41, and 49 have been amended in order to overcome Examiner's objections. However, claim 22 has not been amended since Applicants respectfully deny

Examiner's position as to Norland 65 is supposed to contain esters and/or acrylate monomers. Applicants respectfully submit a Material Safety Data Sheet of Norland Products. This data sheet states in item II that the components are Mercapto-ester. The specific chemical identity and concentration is being withheld from the data sheet as a trade secret. Mercapto-ester is an ester containing a sulfur atom. There is no indication for Norland 65 containing ester in generally or thiols and/or acrylate monomers as recited in claim 22.

Specification

The Examiner asserts that this application does not have an abstract. That is not correct. The application is a national stage application based on PCT/GB98/03011. Enclosed is a copy of the first page of that application as published. The abstract can be found on the first page. So, this application clearly has an abstract. Nevertheless, an abstract is enclosed on a separate sheet as required by 37 C.F.R. 1.72(b).

Claims rejections 35 U.S.C. 102

On page 4, first paragraph, the Examiner rejects claims 1 and 44 under 35 U.S.C. 102(e) as being anticipated by Bryan-Brown et al. US Patent No. 5,754,264, hereinafter called "Bryan-Brown 264". Currently pending claims 1 and 44 have been amended by incorporating the limitation "comprising an oligomer or polymer within the liquid crystal material at the cell walls". This limitation was recited by currently pending claims 2 and 45. Since the Examiner did not reject currently pending claims 2 and 45 under 35 U.S.C. 102(e) it is believed that amended claims 1 and 44 are not anticipated by Bryan-Brown 264 and that the rejection is now moot.

Claims rejections - 35 U.S.C. 103

The independent claims 1, 13, 18, 33 and 44 have been amended by incorporating the limitation "comprising an oligomer or polymer within the liquid crystal material at the cell walls". Therefore the independent claims 1, 13, 18, 33 and 44 have the following claims limitations:

"a liquid crystal device comprising:
a layer of liquid crystal material contained between two spaced cell wall carrying electrodes structures and an alignment treatment on at least one wall,
means for reducing anchoring energy at the surface alignment on one or both cell walls, comprising
an oligomer or polymer within the liquid crystal material at the cell walls."

Claims 3-12, 14-17, 19-32, 34-43 and 46-59 depend from the independent claims 1, 13, 18, 33 and 44. The Examiner rejects claims 1, 2, 44, and 45 on the bottom of page 4, last paragraph, and the first two paragraphs of page 5 as being unpatentable over Bryan-Brown 264 in view of Wu et al. US Patent No. 5,661,533, hereinafter called "Wu et al." The Examiner admits that Bryan-Brown 264 "does not specify that an oligomer or polymer can be used as a means for reducing energy". The Examiner asserts that Bryan-Brown 264 discloses that "a rubbed polymer can be used to simultaneously vary surface pretilt and anchoring energy" and that Wu et al. teach "that a surfectant may be used to lower anchoring energy". Further to this the Examiner asserts that "polymers and similar molecules are surfactants" and therefore it would be obvious to use a surfactant instead of a polymer.

Prima facia case of obviousness

To establish a prima facia case of obviousness three criteria must be met according to the Manual of Patent Examining Procedure (MPEP 2142).

- First there must be some suggestion or motivation either in the reference system cell or in the knowledge generally available to one of ordinary skill in the art to modify the reference or to combine reference teachings.

- Second, there must be a reasonable expectation of success if the references are combined.

- Finally, the prior art references must teach or suggest all the claim limitations.

Applicants submit that the Examiner has failed to satisfy these criteria in asserting that the rejected claims are obvious in view of Bryan-Brown 264 combined with Wu et al.

Bryan-Brown 264 combined with Wu et al. do not teach or suggest all the claim limitations. Bryan-Brown 264 does not teach "an oligomer or short-chain polymer" as admitted by the Examiner. Wu et al. expressly teach against the addition of polymers. See, for example, column four, lines 32-33 "the liquid crystal mix can be free of a polymer gel additive". In column 9, lines 26-29, "one method of forming a display in a light modulation device comprises the steps of: providing a cholesteric liquid crystal cell structure having a liquid crystal mix substantially free of polymer additive". Wu et al. clearly teach away from Bryan-Brown 264 and the present invention.

Bryan-Brown 264 teach that the use of the grating surface according to the abstract "enables surface tilt and alignment anchoring energy to be independently arranged to suit liquid crystal material and device type". Since the use of an appropriate grating surface alone permits independent variation of anchoring energy, Bryan-Brown 264 provides no suggestion or motivation to modify its disclosure by Wu et al. Bryan-Brown 264 does not teach or suggest a need for liquid crystal device according to the present invention. Any motivation to combine Bryan-Brown 264 with Wu et al. or the other prior art references is therefore provided by the Applicant's own disclosure, not by the prior art.

Bryan-Brown 264 deals with alignment in ferroelectric liquid crystal devices whereas Wu et al. deals with multistable reflective cholesteric liquid crystal displays, particularly with how to isolate cholesteric domain from each other. Ferroelectric LCDs and cholesteric LCDs are quite different. Why would one of ordinary skill in the art be motivated to combine the teachings of Bryan-Brown 264 and Wu et al.? What reasonable expectation of success would a person of ordinary skill have in doing so? Finally, what problem would one skilled in the art be attempting to solve by combining Bryan-Brown 264 with Wu et al.?

Clearly the Examiner has combined these two references based on a hindsight reconstruction of the Applicants' claims. Therefore the motivation or suggestion to combine the references is based on the Applicants' own disclosure.

Furthermore, the Examiner asserts that "polymers and similar molecules are surfactants". The applicant does not believe that all polymers are surfactants. Thus, the Examiner is requested to either cite a prior art document supporting his contention or supply an Affidavit as required by 37 C.F.R. 1.104(d)(2). The Applicants submit that the rejection of amended claims 1, 18, 33 and 44 under 35 U.S.C. 103(a) as being unpatentable over Bryan-Brown 264 and Wu et al. is improper. Applicants respectfully request that the rejection of these claims on grounds be withdrawn.

The Examiner rejects on pages 6-7 of the Office Action independent claim 13 under 35 U.S.C. 103(a) as being unpatentable over Hatano et al., US Patent No. 5,920,368 hereinafter called "Hatano et al." in view of Yang et al., US Patent No. 5,847,798 hereinafter called "Yang et al." The Examiner admits that Hatano et al. "do not have a step of reducing anchoring energy" and asserts that Yang et al. "disclose that surface alignment may be accomplished by treating relevant surfaces with a detergent or chemicals". The Examiner further asserts that it would have been obvious to combine the teachings of Hatano et al. and Yang et al. and also to take the step of "forming a polymer in the LC material solution and then to add solvent to dissolve the polymer".

Applicants submit that the Examiner has failed to satisfy the criteria to establish a prima facia case of obviousness in asserting that the rejected claim 13 is obvious in view of Hatano et al. combined with Yang et al. Applicants assert that Hatano et al. and Yang et al. both provide liquid crystal displays in which a cholesteric liquid crystal is contained within face separated domains of polymer. The function of the polymer in Hatano et al. and Yang et al. is to provide the domains which contain the LC and provide a preferred local alignment to the LC molecules. Amended claim 13 requires the oligomer or short-chain polymer to be within the LC material at the cell walls, not phase-separated out of the LC material. The combined teaching of Hatano et al. and Yang et al. teaches away from amended claim 13 because the suggested modification would be totally contrary to amended claim 13. The person skilled in the art would have no motivation to modify the teaching of Hatano et al. by Yang et al. What problem would one skilled in the art be attempting to solve by combining the teachings of Hatano et al. and Yang et al.?

Hence, the Applicants submit that the rejection of amended claim 13 under 35 U.S.C. 103(a) as being unpatentable over Hatano et al. and Yang et al. is improper. Applicants respectfully request that the rejection of claim 13 on grounds be withdrawn.

If the Examiner maintains the rejection of amended claims 1, 13, 18, 33 and 44 on grounds, the Applicants respectfully request that the Examiner show how the references teach or suggest every element of the rejected claims and where the motivation for making the suggested combination can be found in the cited reference. It is believed that independent claims 1, 13, 18, 33 and 44 are allowable and therefore dependent claims 3-12, 14-17, 19-32, 34-43 and 46-59 are allowable as well.

Accordingly, reconsideration and examination of the present application is respectfully requested.

The application is now in condition for allowance. Allowance of the application at an early date is respectfully requested.

The Applicants reserve the right to seek protection for any unclaimed subject matter either subsequently in the prosecution of the present case or in a divisional or continuation application.

The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, then the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136 (a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

I hereby certify that this correspondence is being deposited with the United States Post Office with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, Washington, D.C., 20231 on

January 30, 2003

(Date of Deposit)

Corinda Humphrey

(Name of Person Signing)

Corinda Humphrey

(Signature)

January 30, 2003

(Date)

Respectfully submitted,

Richard P. Berg
Attorney for Applicants
Reg. No.28,145
LADAS & PARRY
5670 Wilshire Boulevard, Suite 2100
Los Angeles, California 90036
(323) 934-2300

Enclosures: Appendix A
Appendix B
Abstract
Copy of first page of PCT/GB98/03011
Norland Products printout
Petition and fee for extension of time
Check for $100.00

Appendix A

Claims:

1. A liquid crystal device comprising:
a layer of a liquid crystal material contained between two spaced cell wall carrying electrodes structures and an alignment treatment on at least one wall,
characterized by
means for reducing anchoring energy at the surface alignment on one or both cell walls, comprising:
an oligomer or polymer within the liquid crystal material at the cell walls.

3. The device of claim 1 wherein the means for reducing energy is an oligomer containing esters, thiols, and/or acrylate monomers within the liquid crystal material at the cell walls.

4. The device of claim 1 wherein the oligomer or polymer has imperfect solubility in the liquid crystal material.

5. The device of claim 1 wherein the oligomer or polymer has a physical affinity for the surface of the cell wall.

6. The device of claim 1 wherein the oligomer or polymer retains a substantially liquid like surface at the polymer and liquid crystal material interface.

7. The device of claim 1 wherein the oligomer or polymer is substantially noncrystalline within the liquid crystal material.

8. The device of claim 1 wherein the oligomer or polymer reduces the liquid crystal material order parameter at or adjacent the cell walls.

9. The device of claim 1 wherein the oligomer or polymer changes the phase of the liquid crystal material at or adjacent the cell walls.

10. The device of claim 1 wherein the oligomer or polymer has a glass transition temperature below the operating temperature range of the device.

11. The device of claim 1 wherein the oligomer or polymer is substantially linear or includes branch points, either with or without crosslinking.

12. The device of claim 1 wherein the oligomer or polymer has a number of repeat units within the range of 4 to 1000.

13. A method of making a liquid crystal device comprising the steps of:
providing a layer of a liquid crystal material contained between two spaced cell wall carrying electrodes structures and an alignment treatment on at least one wall,
characterized by
the step of reducing anchoring energy at the surface alignment on one or both cell walls, providing an oligomer or polymer within the liquid crystal material at the cell walls.

14. The method of claim 13 wherein the oligomer or polymer is formed by polymerization of reactive low molecular weight materials in solution in the liquid crystal material.

15. The method of claim 13 wherein the oligomer or polymer is formed by polymerization of reactive low molecular weight materials in solution in the liquid crystal material prior its introduction between the cell walls.

16. The method of claim 13 wherein the oligomer or polymer is formed by polymerization of reactive low molecular weight materials in solution in the liquid crystal material after to its introduction between the cell walls.

17. The method of claim 13 wherein the oligomer or polymer is formed by polymerization of reactive low molecular weight materials in the presence of an inert solvent which is then removed and the resulting polymer dissolved in the liquid crystal material prior to its introduction between the cell walls.

18. A twisted nematic liquid crystal device capable of being switched from a twisted state to a non twisted state comprising:
two cell walls enclosing a layer of nematic liquid crystal material;
electrode structures on both walls for applying an electric field across the liquid crystal layer;
a surface alignment on both cell walls providing alignment direction to liquid crystal molecules and arranged so that a twisted nematic structure is formed across the liquid crystal layer;

means for distinguishing between the two different optical states of the liquid crystal material; characterized by
means for reducing zenithal anchoring energy in the surface alignment on one or both cell walls, comprising:
an oligomer or polymer within the liquid crystal material at the cell walls.

19. The device of claim 18 wherein the means for reducing zenithal anchoring energy is an oligomer which is coated onto the inner surface of one or both cell walls either spread on the surface or added to the liquid crystal material.

20. The device of claim 19 wherein the means for reducing zenithal anchoring energy is an oligomer incorporated in the liquid crystal material.

21. The device of claim 18 wherein the means for reducing zenithal anchoring energy is N65, or MXM035.

22. The device of claim 18 wherein the means for reducing zenithal anchoring energy is a material containing esters, thiols, and/or acrylate monomers.

23. The device of claim 18 wherein the means for reducing zenithal anchoring energy reduces the liquid crystal material order parameter at or adjacent the cell walls.

24. The device of claim 18 wherein the means for reducing zenithal anchoring energy changes the phase of the liquid crystal material at or adjacent the cell walls.

25. The device of claim 18 including means for reducing azimuthal anchoring energy.

26. The device of claim 18 wherein the surface alignment provides a pretilted nematic alignment on both cell walls.

27. The device of claim 18 wherein the surface alignment is provided by a rubbed polymer, a photo-ordered polymer or an obliquely evaporated inorganic material.

28. The device of claim 18 wherein the surface alignment layer is a surface monograting with an asymmetric groove profile.

29. The device of claim 18 wherein the alignment directions on the two surfaces are substantially perpendicular.

30. The device of claim, 18 wherein the liquid crystal director twists by about 90° throughout the thickness of the cell.

31. The device of claim 18 wherein the liquid crystal director twists is greater than 180° and less than 360°.

32. The device of claim 18 wherein the nematic liquid crystal material contains a small amount (<5%) of a chiral dopant material.

33. A bistable nematic liquid crystal device capable of being switched into two different stable states comprising:
two cell walls enclosing a layer of nematic, liquid crystal material;
electrode structures an both walls;
a surface alignment on one or both cell walls providing two alignment directions to liquid crystal molecules with an amount of surface pretilt; means for distinguishing between switched states of the liquid crystal material;
characterized by
means for reducing inelastic azimuthal memory anchoring energy in the surface alignment on one or both cell walls, comprising:
an oligomer or polymer within the liquid crystal material at the cell walls.

34. The device of claim 33 and including means for reducing zenithal anchoring energy.

35. The device of claim 33 wherein the means for reducing the anchoring energy is an oligomer or polymer which is either spread on the surface or added to the liquid crystal material.

36. The device of claim 35 wherein the oligomer is a material selected from:
Norland N65
$- [S(CH_2)_6S\ CH_2\ CH_2O(CH_2)_6\ O\ CH_2\ CH_2]_n -$
$CH_2=CH\ O(CH_2)_6\ O\ CH=CH_2$ HDVE (Hexane -1,6-diol di(vinyl ether))
$CH_2=CHOC_4H_9$ BVE (Butyl vinyl ether)

$HSCH_2CO_2(CH_2)_2$ OCOCH S_2H EGTG (Ethylene glycol bis(thioglycollate))
$HS(CH_2)_9SH$ NDT (Nonane-1,9-dithiol).

37. The device of claim 35 wherein the oligomer is an amount up to 10 % by weight in the liquid crystal material.

38. The device of claim 35 wherein the chain length (n) is less than 100 repeat units.

39. The device of claim 35 wherein the oligomer's parameters of type, concentration, and chain length, are arranged to reduce the liquid crystal order parameter at or adjacent the cell wall.

40. The device of claim 35 wherein the oligomer's parameters of type, concentration, and chain length, are arranged to change the phase of the liquid crystal material at or adjacent the cell wall.

41. The device of claim 35 wherein the oligomer is a material that has been precured prior to introduction between the cell walls.

42. The device of claim 35 wherein the oligomer is a material that has been precured after introduction between the cell walls.

43. The device of claim 33 wherein the surface alignment is provided by a bigrating surface.

44. A smectic liquid crystal device comprising:
a liquid crystal cell including a layer of smectic liquid crystal material contained between two walls bearing electrodes and surface treated to give both an alignment and a surface tilt to liquid crystal molecules; characterized by
means for reducing anchoring energy at the surface alignment on one or both cell walls, comprising:
an oligomer or polymer within the liquid crystal material at the cell walls.

46. The device of claim 44 wherein the means for reducing energy is an oligomer containing esters, thiols, and/or acrylate monomers within the liquid crystal material at the cell walls.

47. The device of claim 44 wherein the oligomer or polymer has imperfect solubility in the liquid crystal material.

48. The device of claim 44 wherein the oligomer or polymer has a physical affinity for the surface of the cell wall.

49. The device of claim 44 wherein the oligomer or polymer retains a substantially liquid like surface at the polymer and liquid crystal material interface.

50. The device of claim 44, wherein the oligomer or polymer is substantially noncrystalline within the liquid crystal material.

51. The device of claim 44 wherein the oligomer or polymer reduces the liquid crystal material order parameter at or adjacent the cell walls.

52. The device of claim 44 wherein the oligomer or polymer changes the phase of the liquid crystal material at or adjacent the cell walls.

53. The device of claim 44 wherein the liquid crystal material is a chiral smectic material, the alignment directions on the two cell walls are substantially parallel, and the device is a bistable device.

54. The device of claim 44 wherein the alignment directions on the two cell walls are non parallel.

55. The device of claim 44 wherein the liquid crystal material is a non-chiral smectic material.

56. The device of claim 44 wherein the liquid crystal material is a smectic A material.

57. The device of claim 44 wherein the alignment is provided by a grating surface.

58. The device of claim 44 wherein the alignment is provided by a rubbed polymer surface.

59. The device of claim 44 wherein one cell wall has an alignment treatment, the other cell wall has no azimuthal alignment direction, and both cell walls are treated with the means for reducing anchoring energy.

Appendix B

Claims:

1. A liquid crystal device comprising:
a layer of a liquid crystal material contained between two spaced cell wall carrying electrodes structures and an alignment treatment on at least one wall,
characterized by
means for reducing anchoring energy at the surface alignment on one or both cell walls,
comprising:
[2. The device of claim 1 wherein the means for reducing energy is] an oligomer or [short chain]polymer within the liquid crystal material at the cell walls.

3. The device of claim 1 wherein the means for reducing energy is an oligomer containing esters, thiols, and/or acrylate monomers within the liquid crystal material at the cell walls.

4. The device of claim [2]1 wherein the oligomer or [short chain]polymer has imperfect solubility in the liquid crystal material.

5. The device of claim [2]1 wherein the oligomer or [short chain]polymer has a physical affinity for the surface of the cell wall.

6. The device of claim [2]1 wherein the oligomer or [short chain]polymer retains a substantially liquid like surface at the polymer and liquid crystal material interface.

7. The device of claim [2]1 wherein the oligomer or polymer is substantially noncrystalline within the liquid crystal material.

8. The device of claim [2]1 wherein the oligomer or polymer reduces the liquid crystal material order parameter at or adjacent the cell walls.

9. The device of claim [2]1 wherein the oligomer or polymer changes the phase of the liquid crystal material at or adjacent the cell walls.

10. The device of claim [2]1 wherein the oligomer or polymer has a glass transition temperature below the operating temperature range of the device.

11. The device of claim [2]1 wherein the oligomer or polymer is substantially linear or includes branch points, either with or without crosslinking.

12. The device of claim [2]1 wherein the oligomer or polymer has a number of repeat units within the range of 4 to 1000.

13. A method of making a liquid crystal device comprising the steps of:
providing a layer of a liquid crystal material contained between two spaced cell wall carrying electrodes structures and an alignment treatment on at least one wall,
characterized by
the step of reducing anchoring energy at the surface alignment on one or both cell walls[.],
providing an oligomer or polymer within the liquid crystal material at the cell walls.

14. The method of claim [11]13 wherein the oligomer or [short chain]polymer is formed by polymerization of reactive low molecular weight materials in solution in the liquid crystal [fluid]material.

15. The method of claim [11]13 wherein the oligomer or [short chain]polymer is formed by polymerization of reactive low molecular weight materials in solution in the liquid crystal material prior [to] its introduction between the cell walls.

16. The method of claim [11]13 wherein the oligomer or [short chain]polymer is formed by polymerization of reactive low molecular weight materials in solution in the liquid crystal material after to its introduction between the cell walls.

17. The method of claim [11]13 wherein the oligomer or [short chain]polymer is formed by polymerization of reactive low molecular weight materials in the presence of an inert solvent which is then removed and the resulting polymer dissolved in the liquid crystal material prior to its introduction between the cell walls.

18. A twisted nematic liquid crystal device capable of being switched from a twisted state[d] to a non twisted state comprising[;]:

two cell walls enclosing a layer of nematic liquid crystal material;
electrode structures on both walls for applying an electric field across the liquid crystal layer;
a surface alignment on both cell walls providing alignment direction to liquid crystal molecules and arranged so that a twisted nematic structure is formed across the liquid crystal layer;
means for distinguishing between the two different optical states of the liquid crystal material;
characterized by
means for reducing zenithal anchoring energy in the surface alignment on one or both cell walls[.], comparing an oligomer or polymer within the liquid crystal material at the cell walls.

comprising

19. The device of claim 18 wherein the means for reducing zenithal anchoring energy is an oligomer which is coated onto the inner surface of one or both cell walls either spread on the surface or added to the liquid crystal material.

20. The device of claim [18]19 wherein the means for reducing [and] zenithal anchoring energy is an oligomer incorporated in the liquid crystal material.

21. The device of claim 18 wherein the means for reducing zenithal anchoring energy is N65, or [MMXM035]MXM035.

22. The device of claim 18 wherein the means for reducing zenithal anchoring energy is a material containing esters, thiols, and/or acrylate monomers.

23. The device of claim 18 wherein the means for reducing zenithal anchoring energy reduces the liquid crystal material order parameter at or adjacent the cell walls.

24. The device of claim 18 wherein the means for reducing zenithal anchoring energy changes the phase of the liquid crystal material at or adjacent the cell walls.

25. The device of claim 18 including means for reducing azimuthal anchoring energy.

26. The device of claim 18 wherein the surface alignment provides a pretilted nematic alignment on both cell walls.

27. The device of claim 18 wherein the surface alignment is provided by a rubbed polymer, a photo-ordered polymer or an obliquely evaporated inorganic material.

28. The device of claim 18 wherein the surface alignment layer is a surface monograting with an asymmetric groove profile.

29. The device of claim 18 wherein the alignment directions on the two surfaces are substantially perpendicular.

30. The device of claim, 18 wherein the liquid crystal director twists by about 90° throughout the thickness of the cell.

31. The device of claim 18 wherein the liquid crystal director twists is greater than 180° and less than 360°.

32. The device of claim 18 wherein the nematic liquid crystal material contains a small amount (<5%) of a chiral dopant material.

33. A bistable nematic liquid crystal device capable of being switched into two different stable states comprising:
two cell walls enclosing a layer of nematic, liquid crystal material;
electrode structures an both walls;
a surface alignment on one or both cell walls providing two alignment directions to liquid crystal molecules with an amount of surface pretilt; means for distinguishing between switched states of the liquid crystal material;
characterized by
means for reducing inelastic azimuthal memory anchoring energy in the surface alignment on one or both cell walls[.], comprising:
an oligomer or polymer within the liquid crystal material at the cell walls.

34. The device of claim 33 and including means for reducing zenithal anchoring energy.

35. The device of claim 33 wherein the means for reducing the anchoring energy is an oligomer or [short chain]polymer which is either spread on the surface or added to the liquid crystal material.

36. The device of claim 35 wherein the oligomer is a material selected from:

Norland N65

$-[S(CH_2)_6S\ CH_2\ CH_2O(CH_2)_6\ O\ CH_2\ CH_2]_n-$

$CH_2=CH\ O(CH_2)_6\ O\ CH=CH_2$	HDVE (Hexane -1,6-diol di(vinyl ether)
$CH_2=CHOC_4H_9$	BVE (Butyl vinyl ether)
$HSCH_2CO_2(CH_2)_2\ OCOCH\ S_2H$	EGTG (Ethylene glycol bis(thioglycollate))
$HS(CH_2)_9SH$	NDT (Nonane-1,9-dithiol).

37. The device of claim 35 wherein the oligomer is an amount up to 10[.]% by weight in the liquid crystal material.

38. The device of claim 35 wherein the chain length (n) is less than 100 repeat units.

39. The device of claim 35 wherein the oligomer's parameters of type, concentration, and chain length, are arranged to reduce the liquid crystal order parameter at or adjacent the cell wall.

40. The device of claim 35 wherein the ol[o]igomer's parameters of type, concentration, and chain length, are arranged to change the phase of the liquid crystal material at or adjacent the cell wall.

41. The device of claim 35 wherein the oligomer is a material [is a material] that has been precured prior to introduction between the cell walls.

42. The device of claim 35 wherein the oligomer is a material that has been precured after introduction between the cell walls.

43. The device of claim 33 wherein the surface alignment is provided by a bigrating surface.

44. A smectic liquid crystal device comprising:
a liquid crystal cell including a layer of smectic liquid crystal material contained between two walls bearing electrodes and surface treated to give both an alignment and a surface tilt to liquid crystal molecules;
characterized by
means for reducing anchoring energy at the surface alignment on one or both cell walls[.], comprising:
an oligomer or polymer within the liquid crystal material at the cell walls.

[45. The device of claim 44 wherein the means for reducing energy is an oligomer or [short chain]polymer within the liquid crystal material at the cell walls.]

46. The device of claim 44 wherein the means for reducing energy is an oligomer containing esters, thiols, and/or acrylate monomers within the liquid crystal material at the cell walls.

47. The device of claim [45]44 wherein the oligomer or [short chain]polymer has imperfect solubility in the liquid crystal material.

48. The device of claim [45]44 wherein the oligomer or [short chain]polymer has a physical affinity for the surface of the cell wall.

49. The device of claim [45]44 wherein the oligomer or [short chain]polymer retains a substantially liquid like surface at the polymer and liquid crystal material interface.

50. The device of claim [45]44, wherein the oligomer or polymer is substantially noncrystalline within the liquid crystal material.

51. The device of claim 44 wherein the oligomer or polymer reduces the liquid crystal material order parameter at or adjacent the cell walls.

52. The device of claim 44 wherein the oligomer or polymer changes the phase of the liquid crystal material at or adjacent the cell walls.

53. The device of claim 44 wherein the liquid crystal material is a chiral smectic material, the alignment directions on the two cell walls are substantially parallel, and the device is a bistable device.

54. The device of claim 44 wherein the alignment directions on the two cell walls are non parallel.

55. The device of claim 44 wherein the liquid crystal material is a non-chiral smectic material.

56. The device of claim 44 wherein the liquid crystal material is a smectic A material.

57. The device of claim 44 wherein the alignment is provided by a grating surface.

58. The device of claim 44 wherein the alignment is provided by a rubbed polymer surface.

59. The device of claim 44 wherein one cell wall has an alignment treatment, the other cell wall has no azimuthal alignment direction, and both cell walls are treated with the means for reducing anchoring energy.

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(71) Applicants *(for all designated States except US)*: HEWLETT-PACKARD COMPANY [US/US]; 3000 Hanover Street, Palo Alto, CA 94304 (US). THE SECRETARY OF STATE FOR DEFENCE [GB/GB]; Defence Evaluation and Research Agency, Ively Road, Farnborough, Hampshire GU14 0LX (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: BRYAN-BROWN, Guy, Peter [GB/GB]; DERA Malvern, St. Andrews Road, Malvern, Worcs. WR14 3PS (GB). HUI, Victor, Chaklam [GB/GB]; DERA Malvern, St. Andrews Road, Malvern, Worcs. WR14 3PS (GB). JONES, John, Clifford [GB/GB]; DERA Malvern, St. Andrews Road, Malvern, Worcs. WR14 3PS (GB). SAGE, Ian, Charles [GB/GB]; DERA Malvern, St. Andrews Road, Malvern, Worcs. WR14 3PS (GB). WOOD, Emma, Louise [GB/GB]; DERA Malvern, St. Andrews Road, Malvern, Worcs. WR14 3PS (GB).

(74) Agent: LAWRENCE, Richard, Anthony; Hewlett-Packard Limited, Intellectual Property Section, Filton Road, Stoke Gifford, Bristol BS34 8QZ (GB).

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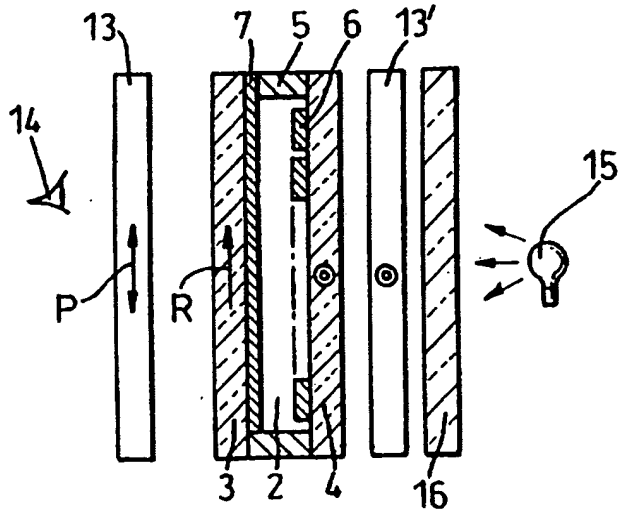
(54) Title: LIQUID CRYSTAL DEVICE ALIGNMENT

(57) Abstract

Liquid crystal devices are formed by a layer of a liquid crystal material enclosed between two cell walls, both carrying electrode structures, and one or both walls treated to align molecules of the liquid crystal material. Most alignment treatment give alignment and surface pretilt with a strong azimuthal and zenithal anchoring energy to contacting liquid crystal molecules. The invention reduces at least one of the azimuthal zenithal or translational anchoring energy to improve switching characteristics and optical performance by allowing movement of liquid crystal molecules at or close to the cell wall. The reduction of anchoring energy may be achieved by an oligomer or short chain polymer which is either spread on the surface or added to the liquid crystal material. The size of oligomer or short chain polymer is low enough that it does not appreciably phase separate from the liquid crystal material. The polymer layer has the characteristics of having imperfect solubility in the liquid crystal material used in the device, of having a physical affinity for the surface of the substrate, and of retaining a substantially liquid like surface at the polymer/liquid crystal interface. The polymer may be formed by polymerisation of reactive low molecular weight materials in solution in the liquid crystal fluid. The resulting solution or dispersion of polymer in liquid crystal is then filled into the cell, and the polymer is allowed to coat the substrate surfaces.



Abstract

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NORLAND PRODUCTS

2540 Route 130, Suite 100, P.O. Box 637, Cranbury, NJ 08512
Tel. (609) 395-1966 Fax (609) 395-9006

MATERIAL SAFETY DATA SHEET
NOA 65

For information or emergency: Telephone 609-395-1966
Date prepared March 1, 2001

I. PRODUCT INFORMATION

TRADE NAME: Norland Optical Adhesive 65

SYNONYMS: NOA 65

PRODUCT USE: Ultraviolet Cure Adhesive

HEALTH	1
FLAMMABILITY	1
REACTIVITY	1
PROTECTIVE	B

Hazard Rating
4 - Extreme
3 - Serious
2 - Moderate
1 - Slight
0 - Minimal
B - Gloves & Eye Protection

II. HAZARDOUS COMPONENTS

COMPONENTS	CAS#	OSHA PEL	ACGIH TLV	LD50	LC50
Mercapto-ester*	*	NE	NE	See Section VI	
Mercapto-ester*	*	NE	NE	See Section VI	

NA = Not Applicable NAv = Not Available NE = Not Established

* The specific chemical identity and concentration is being withheld from this data sheet as a Trade Secret. None of the ingredients are listed as carcinogens in NTP, IARC or OSHA or any state's list of chemicals known to cause reproductive toxicity.

III. PHYSICAL DATA

BOILING POINT (°C): NA

SPECIFIC GRAVITY (H20)=1: 1.2

VAPOR PRESSURE (mm Hg): <0.1 @ 20°C

PHYSICAL STATE: Liquid

VAPOR DENSITY (AIR=1): >1

EVAPORATION RATE: <Butyl Acetate

pH: NA

PERCENT VOLATILE BY VOLUME: <.1

ODOR THRESHOLD (ppm): NAv

FREEZING POINT (°C): NAv

ODOR AND APPEARANCE: Clear liquid; sulfurous odor.

COEFFICIENT OF WATER/OIL DISTRIBUTION: NAv

IV. FIRE AND EXPLOSION DATA

FLASH POINT: 175°C/350°F open cup

FLAMMABILITY: No

EXTINGUISHING MEDIA: Carbon Dioxide, foam, dry chemical.

UPPER FLAMMABLE LIMIT (% By Volume): NA

LOWER FLAMMABLE LIMIT (% By Volume): NA

AUTO IGNITION TEMPERATURE (°C): NA

HAZARDOUS COMBUSTION PRODUCTS: Could generate carbon monoxide and hydrogen sulfide. A small amount of HCN will be generated at incomplete combustion.

EXPLOSION DATA:
Sensitivity to Impact: None
Sensitivity to Static Discharge: None

V. REACTIVITY DATA

CHEMICAL STABILITY: Stable

INCOMPATIBILITY WITH OTHER SUBSTANCES: Exposure to u.v., sunlight or temperatures above 65°C may cause a nonhazardous polymerization reaction.

HAZARDOUS DECOMPOSITION PRODUCTS: None

VI. HEALTH HAZARD DATA

ROUTES OF ENTRY: Inhalation or skin.

EFFECTS OF EXPOSURE:

ACUTE: May cause dermatitis, shortness of breath, fainting, headaches and nausea.

CHRONIC: Repeated or prolonged skin contact may cause sensitization.

EXPOSURE LIMITS: None established for mixture.

LD50 (Mixture): Acute oral (rats) 5 g/km

LC50 (Mixture): Nose only (rats) >2.5 mg/L

CARCINOGENICITY: No

TERATOGENICITY: No

REPRODUCTIVE TOXICITY: No

MUTAGENICITY: No

IRRITANCY OF PRODUCTS: Moderate eye and skin irritant. Inhalation of vapors or mists may cause irritation of the respiratory tract.

SENSITIZATION TO PRODUCT: Can cause an allergic reaction.

SYNERGISTIC PRODUCTS: The use of certain alcohols in conjunction with this product can increase the risk of skin irritation and/or sensitization as they remove the protective oils on the skin.

VII. FIRST AID MEASURES

SPECIFIC MEASURES:

EYE CONTACT: If the material gets in the eyes, immediately wash the eyes with copious amounts of water, occasionally lifting the lower and upper eyelids. Continue for 15 minutes. Get medical attention immediately.

SKIN CONTACT: If the material gets on the skin, immediately wash the area with soap and water and flush with water. If the material gets on clothing, remove the clothing and wash the affected area with soap and water. If irritation develops, get medical attention. Discard or wash contaminated clothing before reuse.

INGESTION: If the material has been swallowed, dilute with milk or water if the victim is alert. See doctor as soon as possible.

INHALATION: If overcome by vapors or fumes, remove to fresh air. Get medical attention if symptoms persist.

VIII. PRECAUTIONS FOR SAFE HANDLING AND USE

PERSONAL PROTECTIVE EQUIPMENT:

GLOVES: Nitrile or butyl rubber.

RESPIRATOR: Not required under normal operating conditions. Respiratory protection may be needed under certain conditions where significant exposure to fumes or mists may occur. An air purifying respirator equipped with organic vapor cartridges is recommended. Selection and use must comply with any existing federal standards for respiratory protection.

EYE: Safety glasses.

FOOTWEAR: Leather shoes.

CLOTHING: Cover arms and legs.

OTHER: NA

ENGINEERING CONTROLS: Use local and mechanical exhaust to minimize exposure to vapors or mists.

LEAK AND SPILL PROCEDURE: Contain material with absorbents. Place in container for disposal. Clean up with soap and water and flush area with water.

WASTE DISPOSAL: Material may be cured solid by exposure to u.v light. Cured material may be disposed of in landfill. Comply with all regulations.

HANDLING PROCEDURES AND EQUIPMENT: Do not reuse container. This product is for industrial use only. Practice good housekeeping and vigorous personal hygiene to minimize contact with material.

STORAGE REQUIREMENTS: Store at 5-25°C. Keep away from sunlight.

SPECIAL SHIPPING INFORMATION: UN NUMBER - Not regulated.

IX. PREPARATION DATE OF MSDS

PREPARED BY: Material Safety Department

TELEPHONE: 609-395-1966

EMERGENCY TELEPHONE: 609-395-1966

DATE: March 1, 2001

SUPERSEDES: August 20, 1997

The data included herein are presented according to Norland Products' practices current at the time of preparation hereof, are made available solely for the consideration, investigation and verification of the original recipients hereof and do not constitute a representation or warranty for which Norland Products assumes responsibility. It is the responsibility of a recipient of this data to remain currently informed on chemical hazard information, to design, and update its own safety program and to comply with all national, federal, state and local laws and regulations applicable to safety, occupational health, right to know and environmental protection.

The chemicals used to manufacture this product are all listed with the Toxic Substances Control Act (TSCA) inventory.